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Original Article

Predicting the Incremental Hospital Cost of Adverse Events Among Medicare Beneficiaries in the Comprehensive Joint Replacement Program During Fiscal Year 2014

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ABSTRACT

Background: The Medicare program's Comprehensive Care for Joint Replacement (CJR) payment model places hospitals at financial risk for the treatment cost of Medicare beneficiaries (MBs) undergoing lower extremity joint replacement (LEJR).
Methods: This study uses Medicare Provider Analysis and Review File and identified 674,777 MBs with LEJR procedure during fiscal year 2014. Adverse events (death, acute myocardial infarction, pneumonia, sepsis or shock, surgical site bleeding, pulmonary embolism, mechanical complications, and periprosthetic joint infection) were studied. Multivariable regressions were modeled to estimate the incremental hospital cost of treating each adverse event.
Results: The risk-adjusted estimated hospital cost of treating adverse events varied from a high of $29,061 (MBs experiencing hip fracture and joint infection) to a low of $6308 (MBs without hip fracture that experienced pulmonary embolism).
Conclusion: Avoidance of adverse events in the LEJR hospitalization will play an important role in managing episode hospital costs in the Comprehensive Care for Joint Replacement program.

The Center for Medicare and Medicaid Services (CMS) began the Comprehensive Care for Joint Replacement (CJR) model in 67 geographic areas on April 1, 2016 [1-3]. The CJR payment model includes any admission of an eligible Medicare beneficiary (MB) to a hospital in Diagnosis-Related Group (DRG) 469 or 470 (major joint replacement or reattachment of lower extremity with or without major complication or comorbidities [LEJR]). The CJR bundled payment includes all Medicare Part A and Part B services during the initial hospitalization through 90 days postdischarge, including rehabilitation facilities, skilled nursing facilities, home health agency, readmissions, and outpatient services [4]. The CJR program will hold hospitals accountable for both the Medicare cost (which is the amount paid by CMS) of care and quality of care they deliver to Medicare fee-for-service beneficiaries undergoing LEJR procedures. Theoretically, the goal of the CJR program is to give hospitals financial incentives to coordinate care among physicians, home health agencies, skilled nursing facilities, and other providers [5-9]. A substantial number of articles have demonstrated that LEJR is a highly successful procedure with relatively low incidence of most adverse events [10-16]. However, relatively little is known about what outcomes impact the total actual hospital cost (which is the dollars spent by the hospital) of care associated with an MB undergoing an LEJR procedure [17-19].

The primary objective of this study is to estimate the effect of selected inpatient adverse events on the incremental treatment hospital cost of the initial hospitalization among MB undergoing

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LEJR procedures during Fiscal Year 2014 in the Medicare program. This study will first report observed adverse event rates for each adverse event for the entire study population and by whether or not the MB was admitted with a hip fracture. In addition, the article reports estimated incremental hospital cost of treating each adverse event using separate multivariable regression models that control for difference in patient demographics and comorbid conditions among MBs undergoing LEJR for all MBs and by whether or not the MB was admitted with a hip fracture.

Methods

Data Source

The Medicare Provider Analysis and Review (MedPAR) file for fiscal year 2014 (October 1, 2013 through September 30, 2014) was the data source for this retrospective analysis. The MedPAR file is an administrative database that is maintained by the CMS and contains all claims that are submitted by hospitals for services provided to MBs. For each hospitalization, a MedPAR record includes patient information on age, gender, race, the principal diagnosis code, up to 24 secondary diagnosis codes, a separate code indicates if each diagnosis code was present on admission, primary procedure code, up to 24 additional procedure codes, length of hospital stay in days, discharge status, total charges, departmental cost, and total reimbursement for that episode of care.

Study Population—Inclusion and/or Exclusion

The population in this study consisted of all hospitalizations in which an MB was assigned a DRG code of 469 or 470. A total of 674,777 MB hospital admissions were identified during fiscal year 2014. No MB's hospitalization for an LEJR was excluded from the study. Although the unit of observation in this article is the MB's LEJR hospitalization, it is worth noting that the number of MBs varied substantially across the 3421 hospitals in this study (mean LEJR volume = 114, median LEJR volume of 197, with hospital LEJR volume range 1-4112).

Definitions of Adverse Events

Eight administratively defined categories of adverse events were defined for this study. The adverse events included in-hospital death; acute myocardial infarction; pneumonia; sepsis or shock; surgical bleeding; pulmonary embolism; periprosthetic joint infection; and mechanical complications. These adverse events were defined per the CMS definitions [20]. In addition, there are specific diagnostic ICD-9-CM codes combined with present on admission codes that differentiate adverse events from a condition existing before the LEJR admission or a procedure code indicating the adverse event occurred during the LEJR admission. Appendix A lists the ICD-9-CM procedure and diagnosis codes used to identify each adverse event reported in this study.

Demographic and Comorbidity Controls

To control for difference in the demographic and severity of illness of MBs undergoing any LEJR hospitalization, we created a number of demographic and comorbidity variables for every MB. Demographic variables of interest included age group (under 65, 65-69, 70-74, 75-79, and 80+); gender (men or women), and race (white, black, Hispanic, or all other). Comorbidities of interest included obesity, body mass index less than 19 kg/m^2, body mass index greater than 30 kg/m^2, malnutrition, depression, dementia, current smoker, history of smoking, type I diabetes mellitus, type II diabetes mellitus, congestive heart failure, acute respiratory failure, chronic respiratory, chronic ischemic heart disease, prior myocardial infarction, hypertension, unstable angina, mild chronic renal failure, moderate chronic renal failure, severe chronic renal failure, history of hemodialysis, chronic kidney disease unspecified, chronic liver disease, aortic aneurysm and dissection of aorta, hyperlipidemia, peripheral vascular disease, cardiomyopathy, valvular heart disease, atrial fibrillation, heart block, prior coronary revascularization procedure, prior cerebral vascular accident, prior venous thromboembolism, rheumatoid arthritis, osteoarthritis, any arthropathy, coagulopathies, anemia, chronic obstruction pulmonary disease, inflammatory bowel disease, any cancer, AIDS, sickle cell disease, psoriasis, nephrotic, long-term use of aspirin, long-term use of antiplatelet, long-term use of NSIADs, long-term use of steroids, long-term use of narcotics, prior total knee arthroplasty, prior total hip arthroplasty, prior total ankle arthroplasty, prior pathologic fracture, prior joint replacement nonspecific, prior liver transplant, prior kidney transplant, and mechanical complications of internal orthopedic device present on admission. All comorbidities were defined based on ICD-9-CM diagnosis codes contained in the MedPAR file.

Study Subpopulations

The primary objective of this study is to estimate the effect of adverse events on the incremental hospital cost of MBs undergoing LEJR. However, DRG 469 and DRG 470 include individuals admitted with and without a hip fracture. As a result, we estimated incremental hospital treatment cost for 2 subpopulations: the 579,077 MBs who underwent a LEJR without a hip fracture present on admission and the 95,700 MBs with a hip fracture present on admission.

Hospital Resource Utilization

This study examined total hospital cost of treating the selected complication of interest. Hospital treatment costs were estimated by multiplying total hospital charges in fiscal year 2014 by the 2014 hospital's overall cost-to-charge ratio, obtained from the hospital's annual Medicare Cost Report. This method of estimating total hospital treatment cost has been discussed and used previously in the literature [21-23].

Statistical Analysis

Univariate differences in baseline demographic data and comorbidities between patients who experienced any adverse event and those who did not were assessed with chi-square analysis or Fisher exact test for discrete variables and Student *t* test for continuous variables. Observed adverse event rates are reported as the proportion of hospitalizations with a selected adverse event out of all study hospitalizations for that study population. Hospital cost for all patients experiencing selected adverse events are presented as mean ± SD. All multivariate regression models were estimated using the linear form of the estimated cost equation. Differences between study groups were considered statistically different if the *P* value was less than or equal to 0.01. All analyses were performed with SAS 9.3 (SAS Institute, Cary, NC).

Strategy for Estimating for Adjusted Resource Use

The multivariate linear regression cost model defined the incremental hospital treatment cost as the estimated coefficient on the dichotomous variable that was set equal to 1 if the patient